DOCUMENT RESUME

ED 162 248 CS 004 303

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TITLE Charting to Compare Children's Learning at Four Different Reading Performance Levels.
PUB DATE May 78
NOTE 24p.; Paper presented at the Annual Meeting of the International Reading Association (23rd, Houston, Texas, May 1-5, 1978)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Elementary Education; Grade 5; *Informal Reading Inventory; Learning Processes; *Reading Instruction; *Reading Level; *Reading Rate; Reading Research; *Research Methodology

ABSTRACT

The Standard Celeration Chart and its related research principles were used in a study to determine the reading level on the informal reading inventory that promotes highest speed or accuracy of learning. For ten school days, 49 fifth graders read and charted their progress at four levels: instructional level, one grade below, and two and six grade levels above the instructional level. The results showed significant differences in distributions of performance scores at the four levels but no significant differences in distribution of learning slopes. The findings challenge reading teaching practices that place a premium on high performance. They also challenge the use of traditional statistical research techniques in reading instruction. (FL)

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ED162248

CHARTING TO COMPARE CHILDREN'S LEARNING AT FOUR DIFFERENT READING PERFORMANCE LEVELS

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Paper presented at the annual convention
of the International Reading Association
Houston, 1978

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CHARTING TO COMPARE CHILDREN'S LEARNING AT FOUR DIFFERENT READING PERFORMANCE LEVELS

Many reading teachers place children in reading materials at the instructional level of an informal reading inventory believing that placing children at this performance level promotes highest learning. This study used the Standard Celeration Chart and its related research principles developed by Lindsley and his students at the University of Kansas to validate a performance level for highest learning. The question was: Is the instructional level of the informal reading inventory or any of three other performance levels a level that promotes highest speed or accuracy learning?

Background

The Standard Celeration Chart

Natural scientists and mathematicians have long recognized the advantages of the semilogarithmic chart for showing proportional and percentage relationships. Since Skinner's pioneering work in operant conditioning (1938), scientists have recognized the precision and universal applicability of frequency for measuring behavior. However, it was not until the middle 60's that Lindsley (1971) combined the semilogarithmic chart with frequency to form a chart, now called the Standard Celeration Chart, that measured proportional changes in behavior.

Early users of this chart noticed that behavioral frequencies on the chart often accelerated or decelerated as time passed. Also, these "celerations" were generally linear.

If indeed, the changes in behavioral frequencies were linear on a semilogarithmic scale, then behavior changed by a constant multiple rather than by a constant addend, or like the compounding interest of a savings account rather than like uniform deposits to a cash box.

In 1972, Koenig used over a thousand phases of behavioral frequencies with over 10 percent change per week, from research journals and the Behavior Bank (1971), to confirm that linear celerations on the Standard Celeration Chart appropriately represented changes in behavior. The straight lines drawn through at least ten frequencies bisected the frequencies and the variance on the Standard Celeration Chart.

Since 1972, many research projects, involving thousands of children have confirmed Koenig's findings and challenged traditional analysis of research data by add gains.

The Standard Celeration Chart is not new to the world of reading research. Of special significance to this study was Johnson's 1971 study that showed frequencies on the Standard Celeration Chart measured reading performance and learning in several curricula tried only minutes apart. Another study (Stiles and Martin, 1973) showed reading frequencies and changes in reading frequencies were normally distributed on the semilogarithmic scale, that is, were spread across

people by the same multiple up as down. Findings from both of these studies became part of the research design for this study which compared distributions of frequencies and changes in frequencies from different grade levels of curricula tried only minutes apart.

The Informal Reading Inventory

The informal reading inventory (IRI) is a widely used technique for placing students in materials. The IRI uses a series of passages from materials representing different grade levels. The student reads the passages orally and answers comprehension questions while the teacher records errors. The teacher places the student for instruction in materials in which the student reads passages at some defined performance level.

Did highest learning data validate any of the currently used instructional performance levels of the IRI? A literature search, tracing over 20 bibliographic references from articles on validity of the IRI referenced in the Education Index since 1940, revealed only one effort to validate an instructional level of highest learning.

Cooper (1952) tested 1000 elementary children and found that, as a group, children who made the fewest word recognition errors made the greatest gains in reading achievement. Cooper concluded that instructional level criteria of the IRI should be 96-98 percent accuracy for word recognition and

60-70 percent accuracy for comprehension.

Would Cooper have arrived at the same conclusion if he had assumed that behavior changed by a constant multiple? This study found that the children in Cooper's study with the highest accuracy and gains also had the highest mean pretest score. Charting Cooper's results on the Standard Celeration Chart showed that the multiply gains for each group of children in Cooper's study were nearly identical (Table 1). Cooper's conclusions were based on looking at learning as add gains rather than as multiply gains. The question remained: Is the instructional level of the IRI or some other performance level a level that promotes highest speed or accuracy learning?

Insert Table 1 here

Methods

This study included 49 fifth graders in a Kansas rural school district. Each child received an informal reading inventory using rate builders from Scientific Research Associates (SRA) reading laboratory IIb. These rate builders were selected because they represented the actual materials the children used later in the study. Each child's instructional level was the highest grade level in which the child had at least 95-99 percent word recognition accuracy and

75-90 percent comprehension accuracy. Substitutions, mispronunciations, assisted words, punctuation skips, insertions, hesitations, and omissions as defined by McCracken (1967) counted as errors. Of eleven authors reviewed by Powell (1971) these percentage levels and error criteria were recommended by more authors than any others.

For at least 10 school days the children read and charted their progress at four levels: their instructional level, one grade level below, and two and six grade levels above that instructional level. At least ten school days were required to measure learning at each level for each child (Koenig, 1971). The steps between the grade levels increased by doubling (+1, +2, +4) and represented performance levels from nearly perfect to high error.

The daily procedure was as follows:

1. Untimed silent reading of a story from one of four randomly ordered SRA rate builders. Opportunity for help with new words or content.
2. One minute timing on SRA multiple choice comprehension questions. (see-mark)
3. Checking of comprehension answers. Charting correct and error number per minute on the Standard Celeration Chart.
4. One minute word recognition timing. (see-say)

5. Checking words read. Charting correct and error number per minute on the Standard Celeration Chart.
6. Repeating 1 through 5 for the other three levels.

Results

The daily procedures generated at least 10 frequencies for each of 16 reading behaviors--corrects and errors in both word recognition and comprehension at each of the four placement levels--for each child.

Figure 1 shows an example of one child's frequencies pinpointed on a Standard Celeration Chart. Each series of correct frequencies (.) and error frequencies (x) represents the celeration of corrects or errors per minute in word recognition or comprehension at one of the four placement levels. Each 5-week column contains the series of reading frequencies for one placement level. The top row contains the series of reading frequencies for word recognition and the bottom row for comprehension. The two dotted horizontal lines labeled "floor" show the lowest behavior frequency the one minute timings could detect (one per minute). A frequency of zero is plotted below this floor meaning the behavior occurred at some unobserved point less than one per minute.

Insert Figure 1 here

For speed and accuracy performance indices, the study used the median frequency for each reading behavior of each

child and the accuracy multiplier for each related median frequency pair. The accuracy multiplier is the number a median error frequency is multiplied by to get its related median correct frequency. It tells the number of correct responses there were for each error response.

For an index of speed learning, the study used freehand lines drawn through each set of at least 10 frequencies. The slope of each line was measured with a celeration finder.

Users of the Standard Celeration Chart developed the celeration finder for quickly measuring celeration lines. The celeration finder measured how much frequencies multiplied or divided per week like a protractor measured an angle.

The Pearson product-moment correlation coefficient between the slope of these lines and the slope of lines drawn by the linear regression formula was r=+.88. (This high correlation between freehand lines and formula-drawn lines with celerations from ÷2.00 to ×2.00 was lower than, but comparable to, the correlation of r=+.99 shown by Hnetish (1977) for celerations of X1.05 to X13.00).

For an index of accuracy learning, the study used the accuracy improvement multiplier. The accuracy improvement multiplier tells how much the accuracy multiplier multiplied or divided each week. For example, a child with an accuracy improvement multiplier of X1.5 might have the accuracy multiplier go from X2.0 to X3.0 to X4.5 in three weeks.

The speed and accuracy performance indices and the speed

and accuracy learning indices were analyzed in stages. The first stage answered the question: Did the four placement levels represent different performance levels for the children? The second stage answered the study's central research question: Was the instructional level of the IRI or any of the other three performance levels a level of highest speed or accuracy learning?

Did the four placement levels represent different performance levels for the children?

The study compared children's speed performances at the four placement levels by charting distributions of children's median frequencies for corrects and errors in word recognition and comprehension at each placement level. Figure 2 shows these distributions. Each . (corrects) and X (errors) represents the median frequency performance of one child. The 16 distributions charted on the Standard Behavior Chart spread across the 49 children by the same multiple up as down except for errors per minute at the lower three placement levels. At these levels the median frequencies spread across children by a larger multiple up than down. The distributions appeared to "bottom out" as it the materials were too easy for any children to exhibit any fewer errors.

Insert Figure 2 here

The distributions were compared visually and statistically. Visually the distributions apeared to differ most at the top three placement levels. Statistically a Median test of exact probability (Siegel, 1956) computed for the distributions showed each distribution of median correct frequencies was significantly lower and each distribution of median error frequencies was significantly higher with each successively higher placement level ($p < .01$) except between one grade level below the instructional level and the instructional level.

The study compared accuracy performances by charting distributions of accuracy multipliers for word recognition and comprehension at each placement level. Again, the distributions spread across children by the same multiple up as down except for word recognition at the bottom two performance levels. At these levels the distributions seemed to top out as if students reached some ceiling. Median tests showed significant differences between each successively higher placement level ($p < .01$) except between one grade level below the instructional level and the instructional level. Each distribution of accuracy multipliers was significantly lower with each successively higher placement level.

Was the instructional level of the IRI or any of the other three performance levels a level of highest speed or accuracy learning?

To determine whether or not any of the performance levels was a level of highest speed or accuracy learning, the study compared distributions of correct celerations, error celerations, and accuracy improvement multipliers.

Visual and median test comparisons of distributions for correct celerations, error celerations, and accuracy improvement multipliers in word recognition and comprehension at the four placement levels showed normally spread distributions but no significant differences for any placement level. ($p > .01$) The study concluded that for the group of children, no performance level was a level of highest learning.

Discussion

This study used the Standard Celeration Chart and its related research principles to examine the question: "Is the instructional level of the informal reading inventory or any of three other performance levels a level that promotes highest learning?" Conclusions were:

1. The inventory instructional level, two grade levels above the inventory instructional level, and six grade levels above the inventory instructional level represented significantly different performance levels for the children in the study.
2. Distributions of speed and accuracy celerations showed no significant differences in children's learning at any of the performance levels. Thus,

for the group of children, neither the inventory instructional level or any of the other performance levels promoted highest learning.

Implications of research findings for educational practice

The findings from this study challenge reading teaching practices that place a premium on high performance. One of these practices is the practice of placing children in reading materials at the instructional level of the informal reading inventory. If placement at this level does not promote highest learning, should teachers use the level at all? Further research is needed to test whether or not placement at the inventory instructional level achieves any other purpose such as reading satisfaction, adequate comprehension, or proper skill sequencing.

Did this study eliminate the need for an informal reading inventory? Although the inventory is apparently not valid as an instrument for selecting a performance level of highest learning, the inventory may still be useful for assessing strengths and weaknesses in children's subskills. The study only challenged one use of the informal reading inventory.

Limitations to the research findings

The study had several limitations.

The study included only fifth grade children who were reading at a third grade level or better. All of these children had mastered a basic vocabulary. The study did not

resolve the question of how performance levels effect learning for beginning readers.

The study did not use direct teacher instruction as part of the daily exposure to the SRA materials. Any learning that occurred was primarily the result of children's daily practice in the material. Direct teacher instruction might promote higher learning at some performance levels than others.

Finally, the methods for the study varied from most classroom settings in that children worked at changes in their performance rather than at maintaining a nearly perfect performance level. As a result, errors became change opportunities rather than failure indicators. This different way of viewing errors may have influenced the effect of performance on learning. More research is needed on the relationship between children's learning and teacher attitudes towards errors.

Observations on the use of the Standard Celeration Chart

How effective was the Standard Celeration Chart as a research instrument?

1. The chart allowed visual comparisons of distributions. This visual comparison had the same advantages over strictly statistical comparisons that a photograph has over a verbal description.
2. The chart proved appropriate for comparing children's behavioral frequencies. The charted frequencies and distributions substantiated Lindsley's claims that learning is linear on a semilogarithmic scale and

that human behaviors spread across people by the same multiple up as down.

3. The chart was an efficient research tool. Although this study used both statistical and visual comparisons and drew lines by both the linear regression formula and freehand, the visual and freehand methods alone produced adequate information to formulate the research conclusions.
4. The study assumed from other research that the frequencies were sensitive and specific enough to allow a comparative study between several curricula tried minute apart during the same class period. The results of this study confirmed this assumption. The children had different frequencies and different celerations at each level (Neufeld, 1978).
5. Using the chart meant using a different language for describing data collection and analysis. Even though the language of the Standard Celeration Chart was common English, the common English was applied in new ways. Each concept needed defining or illustrating.

A prediction

Educators seldom question the use of high performance levels for reading instruction or the use of traditional statistical research techniques. This study challenged both.

The findings and techniques described in this study deserve careful evaluation. If substantiated, they could revolutionize current research and teaching practices.

Table 1. Six-month Achievement Gains for Students Making Different Numbers of Errors Per 100 Words (Cooper, 1952)

	Mistakes Per 100 Words	Number of Students	Mean Achievement Pretest Score	Mean Achievement Posttest Score	Add Gain	Multiply Gain
Primary	0-1.99	160	3.38	4.28	+.90	X1.27 or +27%
	2-3.99	87	3.17	4.03	+.86	X1.27 or +27%
	4-5.99	84	2.81	3.52	+.71	X1.25 or +25%
	6-9.99	65	2.67	3.34	+.67	X1.25 or +25%
	10+	91	2.28	2.86	+.58	X1.25 or +25%
Intermediate	0-1.99	108	6.72	7.70	+.98	X1.15 or +15%
	2-3.99	86	5.90	6.76	+.86	X1.15 or +15%
	4-5.99	46	5.26	6.10	+.84	X1.16 or +16%
	6-9.99	45	4.66	5.34	+.68	X1.15 or +15%
	10+	47	3.86	4.21	+.35	X1.09 or + 9%

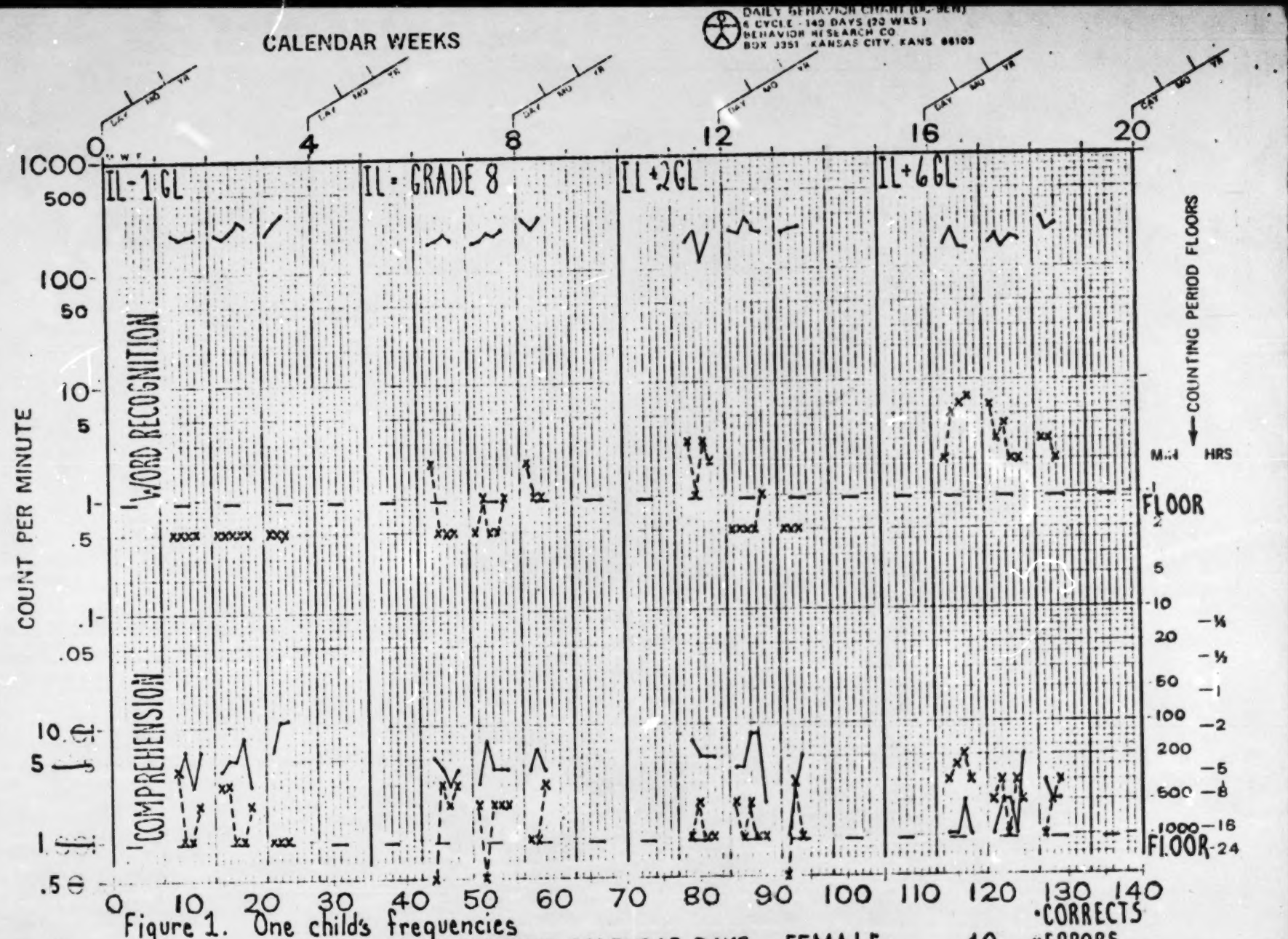

Figure 1. One child's frequencies

FEMALE 10

IL - INSTRUCTIONAL LEVEL

GL - GRADE LEVEL

SUPERVISOR ADVISER MANAGER

DEPOSITOR AGENCY COUNTER

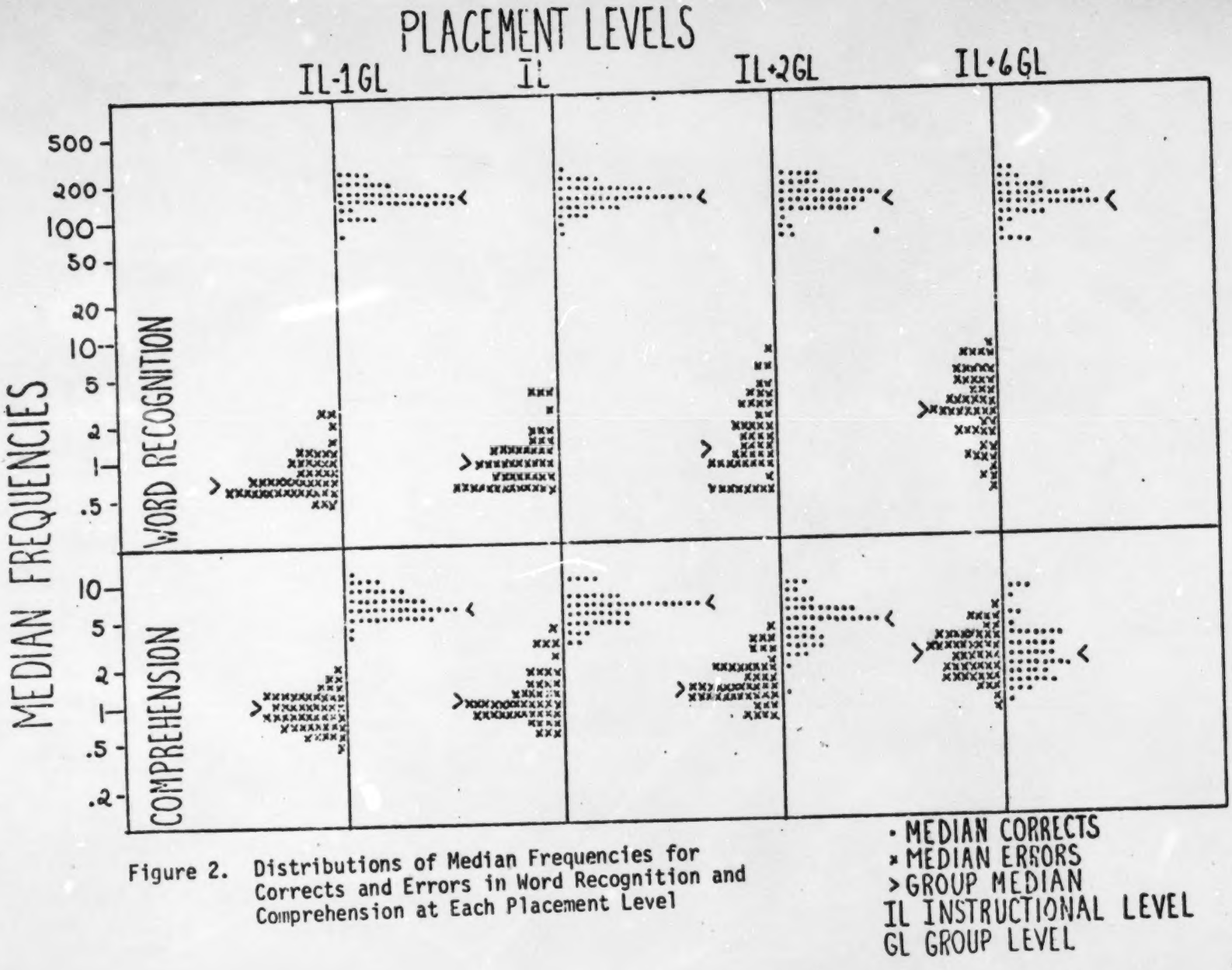

Figure 2. Distributions of Median Frequencies for Corrects and Errors in Word Recognition and Comprehension at Each Placement Level

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